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STATE OF CALIFORNIA
DIVISION OF HIGHWAYS
MATERIALS AND RESEARCH DEPARTMENT

REPORT ON THE OPERATIONS
OF THE
MATERIALS AND RESEARCH DEPARTMENT



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By

**F. M. Eveum
Materials and Research Engineer**

May 3, 1954

REPORT ON THE OPERATIONS
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MATERIALS AND RESEARCH DEPARTMENT

The Materials and Research Department was organized shortly after the Highway Department was created, being originally established in 1912 under the direction of Chief Geologist Mr. C. B. Osborne. The first Testing Engineer was Mr. F. T. Maddocks.

The first laboratory building consisted of a small wooden building on the State Fair Grounds, which site was occupied until 1922 when a one story brick building was constructed at 3435 Serra Way which, with extensions and use of warehouse type buildings, constitutes the present site.

The department has grown and activities have expanded steadily in the 40 year period. However, the expansion has only been in proportion to the expansion of the Division of Highways as a whole. Figure I shows the generally constant relationship in number of employees for the last 15 years.

Before proceeding with a discussion of the present status of the Materials and Research Department of the Division of Highways, a few general comments may be in order as a background.

First, it is a rather difficult matter to make comparisons between laboratories. As a result of requirements set forth in the original Federal Aid Act, each state desiring to participate in Federal Aid must maintain a well equipped laboratory. Because of the size of this state and amount of money spent for highways only New York or Texas offer any basis for direct comparison. However, a comparison with private industry may be of interest as the majority of large industrial agencies apparently consider that research and development work is a very profitable investment. Table I gives the comparative figures indicating the percentage spent for research by twelve large industrial organizations in the United States. For comparison, the total expenditures for the Division of Highways are shown for the same period and the total expenditures of the Materials and Research Department which include routine testing are also shown. It will be evident that on a percentage basis our expenditures are substantially below those considered justifiable by most private organizations of comparable size.

The work of the Materials and Research Department is logically classified under three headings:

1. Research work aimed at developing new test methods and procedures having general application.
2. Special investigations undertaken to determine the causes for specific happenings or development.
3. Routine procedures which involve sampling, testing, and reporting, using established procedures on materials proposed for use on contemplated work or actually being used in work under way.

Figure II shows the proportional amount of salary expense devoted to the standard procedures, to the special investigations, and to research. It may be mentioned in passing that certain organizations would classify the special investigational phase as research and in certain viewpoints what we are doing would be classed as fundamental research and applied research.

So far as total expenditures are concerned, Figure III illustrates the ratio between the expenditures of this department and the total expenditures for construction and maintenance for the last 15 years. Except for the disturbance created by the war, it is evident that the total cost for operating this department has remained relatively constant on a percentage basis, averaging about .9% and rarely exceeding 1% of the total expenditures for construction and maintenance. Figure IV illustrates this fairly constant relationship since 1946 compared to the expenditures for construction alone. The relative expenditures for preliminary engineering are also shown for comparison.

The work of the Materials and Research Department is subdivided into five Sections as follows:

<u>Section</u>	<u>Section Head</u>	<u>Title</u>
Technical	B. Tramper	Supv. Materials & Research Eng.
Structural	J. L. Beaton	Supv. Highway Engineer
Materials	H. R. Cedergren	Senior Materials & Research Engr.
Administration	A. W. Root	Supv. Materials & Research Eng.
Foundation	E. Zube	Supv. Materials & Research Eng.
Pavement		

The total expense including salaries, equipment rental and materials disbursed under the direction of each Section Head is illustrated in the Chart, Figure V. Figure V shows the proportional total expense characteristic of each section based on a

year's average. However, another rearrangement of cost distribution is necessary to determine the amounts properly assigned to each class of materials or item. For example, the Foundation Section under A. W. Root includes the materials classification sub-section which crushes and grades all aggregates, determines specific gravity, hardness and other characteristics and furnishes the data to the other sections as required. In a similar manner both the Technical Section and Structural Materials Section do a considerable amount of work for the other sections. Expenditures for the Foundation Section on Chart, Figure V, include equipment rental and supplies which account for the larger proportion allotted to the Foundation Section.

In view of the fact that we are here primarily concerned with the allocation of personnel, Chart, Figure VI, has been prepared showing the distribution of the payroll under 13 different headings. A further study of the duties and assignments of the employees led to a breakdown according to the individual duties and responsibility which resulted in 12 classifications as shown in Figure VII. In this breakdown I believe that the classification terms are fairly self-explanatory. However, taking up the segments clockwise on Figure VII:

Supervisory covers all individuals from the Department Head down who spend all or part of their time supervising the work of others.

Advisory refers to the time spent in answering questions by telephone, making recommendations to other Departments of the Division of Highways or to other agencies.

Analysis of Data refers to time spent in studying figures, preparing diagrams of slide and foundation problems, studying test data and preparing analyses of the departmental operation and doing associated work necessary to arrive at a conclusion and to make recommendations.

Technical Report Writing covers time of the individual composing reports on special investigations and routine work on slides, slipouts, committee reports of national organizations, etc.

Drafting & Illustration includes the work of the drafting room, preparation of photographs and slides, multigraph and ditto machines, etc.

Inspection refers primarily to the work of the Branch Laboratories in Los Angeles, Berkeley, Bakersfield and Santa Maria. It also includes the time of one or two individuals operating out of Sacramento.

Sampling refers to time spent by men in the Branch Laboratories and also by those in the Foundation Section for taking samples from vertical drilled holes.

Testing covers all routine operations either in the field or in the laboratory involved in securing factual data. Thus, field inspections by the geologists and others would be grouped under this category.

Operation of Drilling Equipment is intended to segregate the time of the foundation drilling foreman, drillers, HEOL, and laborers involved in the mechanical phases of boring holes either for the purpose of securing samples or to relieve and correct slide conditions.

Mechanical covers all activities such as instrument maker, machinist, electrician, carpenter plus helpers who are involved in the development, repair and manufacture of equipment.

Service includes such individuals as janitors, drivers of pickup rigs who transport materials from the laboratory to the warehouse and miscellaneous operations of this sort. There is, of course, no clear-cut, sharp line between those classed in the mechanical trades and those engaged in services for a department such as this.

Clerical includes all individuals engaged in stenographic work, typing, accounting, personnel, filing, etc.

The intent of the discussion up to this point and the charts shown has been to convey an idea of the proportional expense for salaries that falls within the different categories. In order to examine the detailed activities of the Materials and Research Department as a whole a second set of tabulations is presented employing the principle of continuously subdividing the main divisions in order to convey some idea either of the operations or of the variety of materials covered. In addition, these tabulation charts list the agencies which utilize the service of the department and the agencies with which the Materials and Research Department must maintain contact, serve on committees, engage in cooperative work or in exchange of information.

Figure A is an overall breakdown chart of the department as a whole showing the five sections and subdivisions followed by greater detail of the typical activities. The figures encircled indicate the approximate number of individuals in each section or sub-section.

I am aware, of course, that Headquarters policy now favors transferring as much work to the districts as they are able to handle, and, recognizing the advantages of decentralization, this department initiated the move in 1949 when we recommended and Mr. Gillis approved the expenditure of substantial sums for testing equipment in order that the district laboratories would be in a position to perform all tests that are of immediate concern in the planning and setting up of highway projects and in control of materials during construction.

As the title Materials and Research Department emphasizes, our main concern is with materials and virtually all materials are produced or processed by some private firm or agency, whether as manufacturer or contractor, and it is very important that materials specifications be administered by those who thoroughly understand the nature of the tests involved and that all individuals who furnish materials to the state should receive the same treatment and consideration so far as possible. Even with the best of intentions and ability, such uniform policy would be very difficult to maintain by a number of districts operating independently, and the fact that much of the manufacture and source of supply is concentrated in the two large industrial areas of the state means that it would be highly impractical for the more remote districts to handle the inspection of structural steel, cement, or asphalts at the source, to say nothing of the numerous other commodities.

I think that it is not inappropriate to point out that over a period of many years there have been exceedingly few cases where the vendors of materials have registered serious complaint citing unfair or unsatisfactory treatment so far as the department is concerned, and those who have listened to the complaints of contractors who contrast the interpretation of specifications and different treatment accorded between individual districts and the Bridge Department of the Division of Highways will appreciate that such dissatisfaction could be greatly amplified if an attempt were made to place the inspection, testing, and acceptance of manufactured products solely in the hands of the individual districts. In addition to the duplication of activity, cost of equipment, and inevitable confusion, it would be virtually impossible today to secure a sufficient number of people trained in materials work to handle this phase on a district basis.

The charts and graphs thus far submitted have dealt with the distribution of our activities with reference to divisions of responsibility according to activity and type of materials or phase of construction work involved. In order to indicate the geographical distribution, a map of the state has been prepared showing the locations where representatives or crews of the various Headquarters Laboratory Sections have been engaged in work during the past year. The circles placed on the map indicate the approximate areas where someone representing the Materials and Research Department has spent a measurable amount of time in field work of some sort.

It will be noted that all sections except the Administration Section are represented, and I wish to emphasize that these points represent a substantial amount of time spent. In addition, there are numerous field trips made by the sections to confer with or assist the district laboratories and also to consult with engineers in the individual districts. No attempt was made to show the number of individuals or the amount of time spent on such visits and the time is included in the portion allotted to Routine Testing and Advisory on Chart, Figure VII.

A consideration of the activities of the Headquarters Materials and Research Department both in Sacramento and in various locations throughout the state brings to mind that the closest comparable unit of the Division of Highways is probably the Bridge Department. It is also perhaps of interest to note that the distribution of personnel, that is the relative number in each category from Principal Engineer down, is very similar in both departments, the Bridge Department, of course, being approximately three times the size of the Materials and Research Department.

In conclusion, it may be pointed out that so far as possible the activities of Headquarters Laboratory are being shifted from routine testing to the investigational and research type of work. Routine testing work on soils and local materials is being diverted to the District Laboratories and we are making use of private laboratory facilities where feasible and appropriate.

As pointed out before, the expenditures of this department for materials control and especially for research are very conservative compared to the expenditures of most large industrial organizations.

Respectfully submitted,

Original Signed by F. N. Hveem

F. N. HVEEM
Materials & Research Engineer

Attach.

FNH:cm

TABLE I

COMPARATIVE RESEARCH AND DEVELOPMENT
EXPENDITURES

Organization	Costs & Operating Expenses 1951		Research & Development Expenditures 1951	Percent Research of Total Expenditures
	Costs & Expenses of Production	Selling Costs, Admin. & Gen. Expenditures		
Standard Oil Co. (N.J.)	\$2,375,104,381	\$258,171,242	\$2,633,275,623	0.9
American Cyanamid Co.	225,467,617	72,388,648	297,856,265	5.3
American Tel. & Tel. Co.	144,372,951	42,852,493	187,225,444	8.1
Kodak Co.	362,393,262	56,398,617	418,793,885	3.6
Allied Chemical & Dye Corp.	351,020,347	44,058,650	395,078,997	2.8
International Bus. Mach. Co.	128,747,729	64,195,543	192,943,272	3.9
Owens-Illinois Glass Co.	237,415,127	23,722,520	261,137,647	2.2
Hercules Powder Co.	147,180,842	26,484,127	173,664,969	3.1
Kerk & Co.	65,276,495	20,907,661	86,184,156	5.5
Corning Glass Works	80,840,947	12,211,112	93,052,059	3.9
Colgate-Palmolive Peet Co.	140,846,387	69,429,401	210,275,788	1.7
Douglas Aircraft Co.	194,869,355	10,450,070	205,319,425	0.7
			Average	4.5
Calif. Div. of Highways			160,000,000	0.5

1. Total laboratory expenditures in 1951 includes both routine and research.

Ratio of Number of Lab. Employees to total for Div. of Highways-%

Fig. I

RATIO OF LAB. EMPLOYEES
TO
DIV. OF HIGHWAYS EMPLOYEES-%

2.0
1.8
1.6
1.4
1.2
1.0

1930

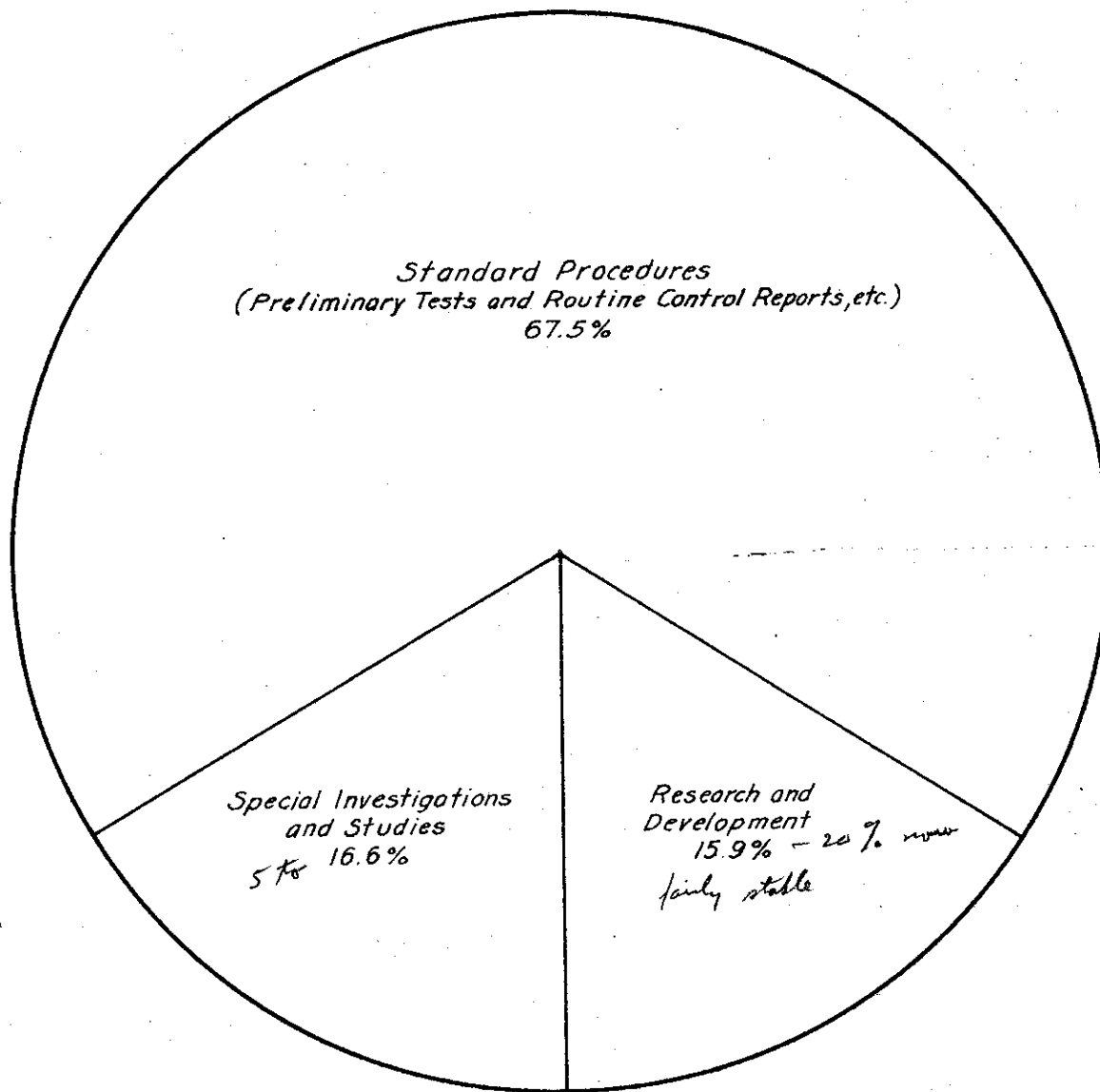
1940
Year

1950

Data on number of employees
of Division of Highways were
obtained from Personnel Dept.
of Div. of Highways.

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Fig. II
Typical Laboratory Payroll Distribution
Based on Classification of Work
(June, 1953 Payroll)

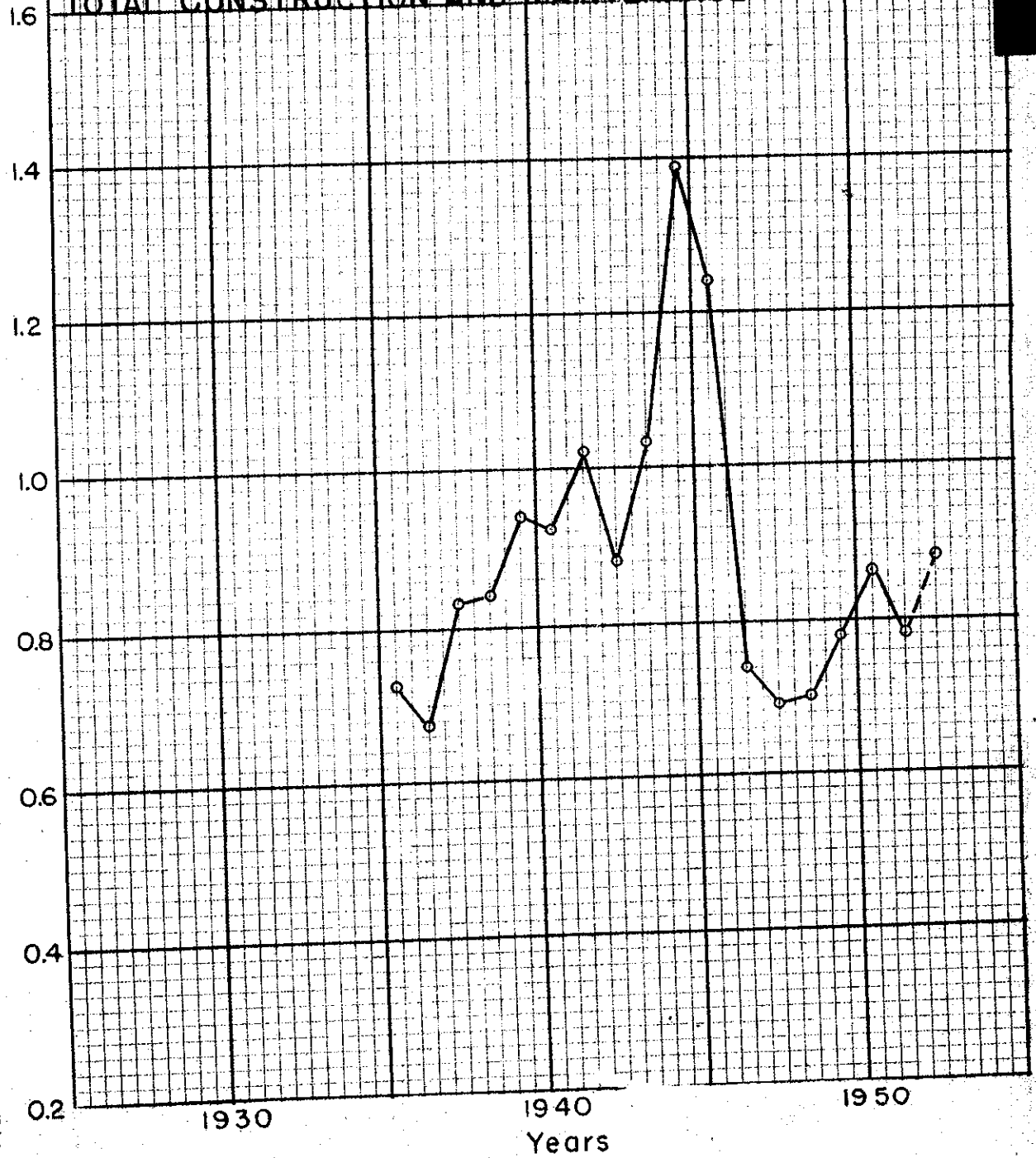


Ratio of Laboratory Expenses to Total Construction and Maintenance Expenditures--%

Fig. III

RATIO OF LABORATORY EXPENSES
TO

TOTAL CONSTRUCTION AND MAINTENANCE EXPENDITURES

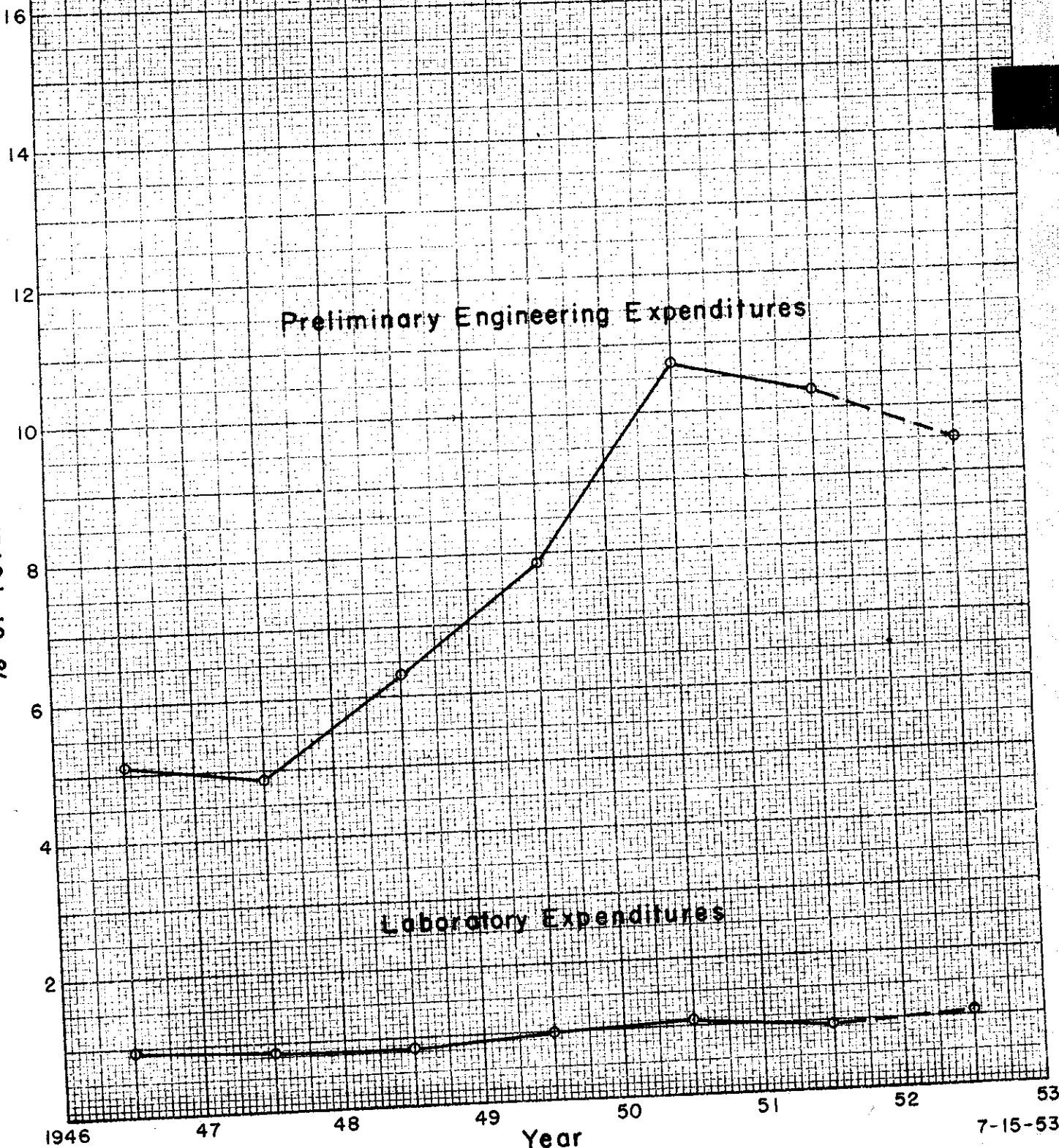


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Fig. IV

Preliminary Engineering Expenditures and Laboratory Expenditures as % of Total Construction Expenditures

359T-116 KEUFFEL & ESSER CO.
10 X 10 to the 1/2 inch, 5th line horizontal
MAG. 8 X 10



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Fig. V
Distribution of Expense
Materials and Research Dept.

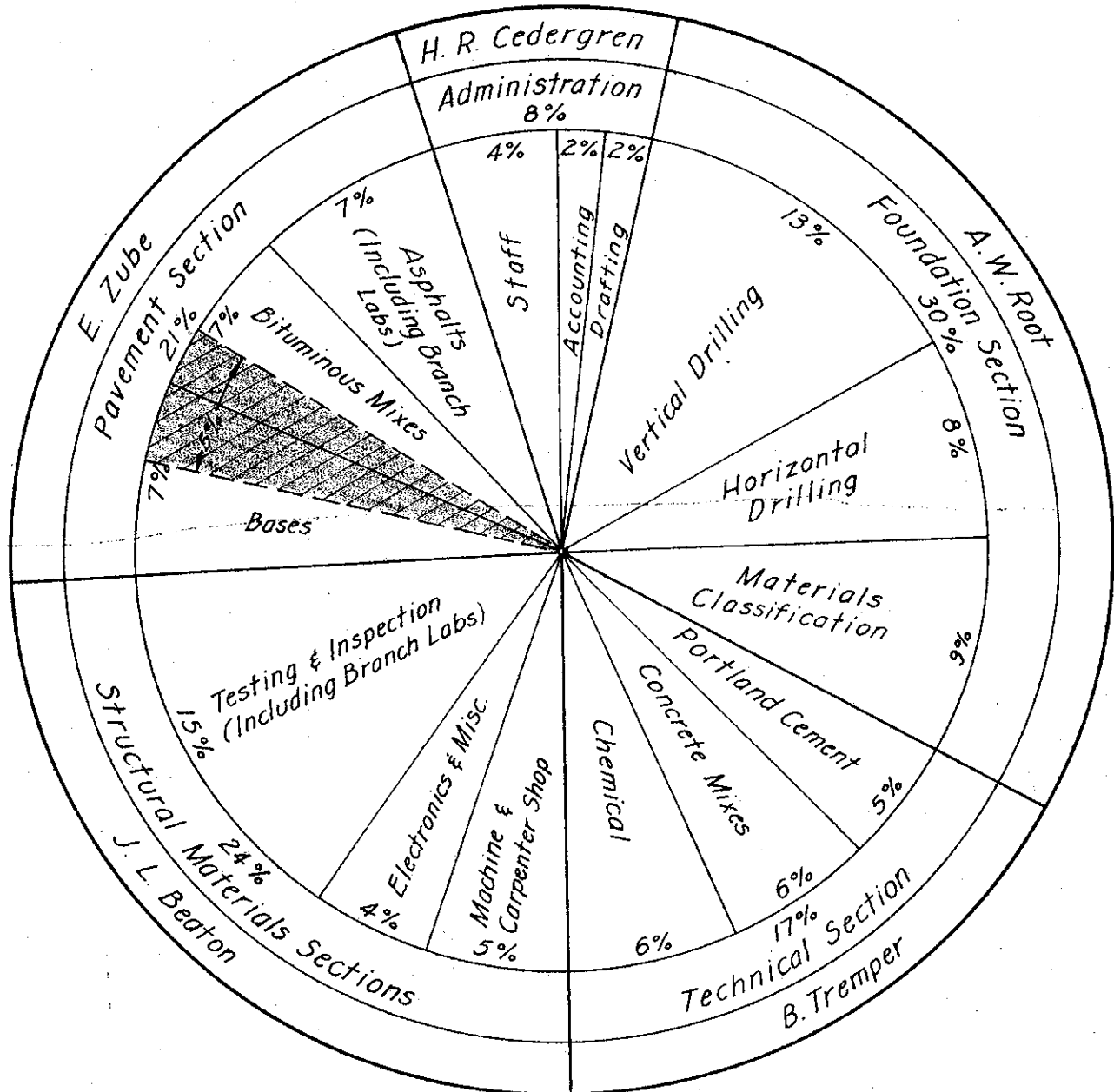
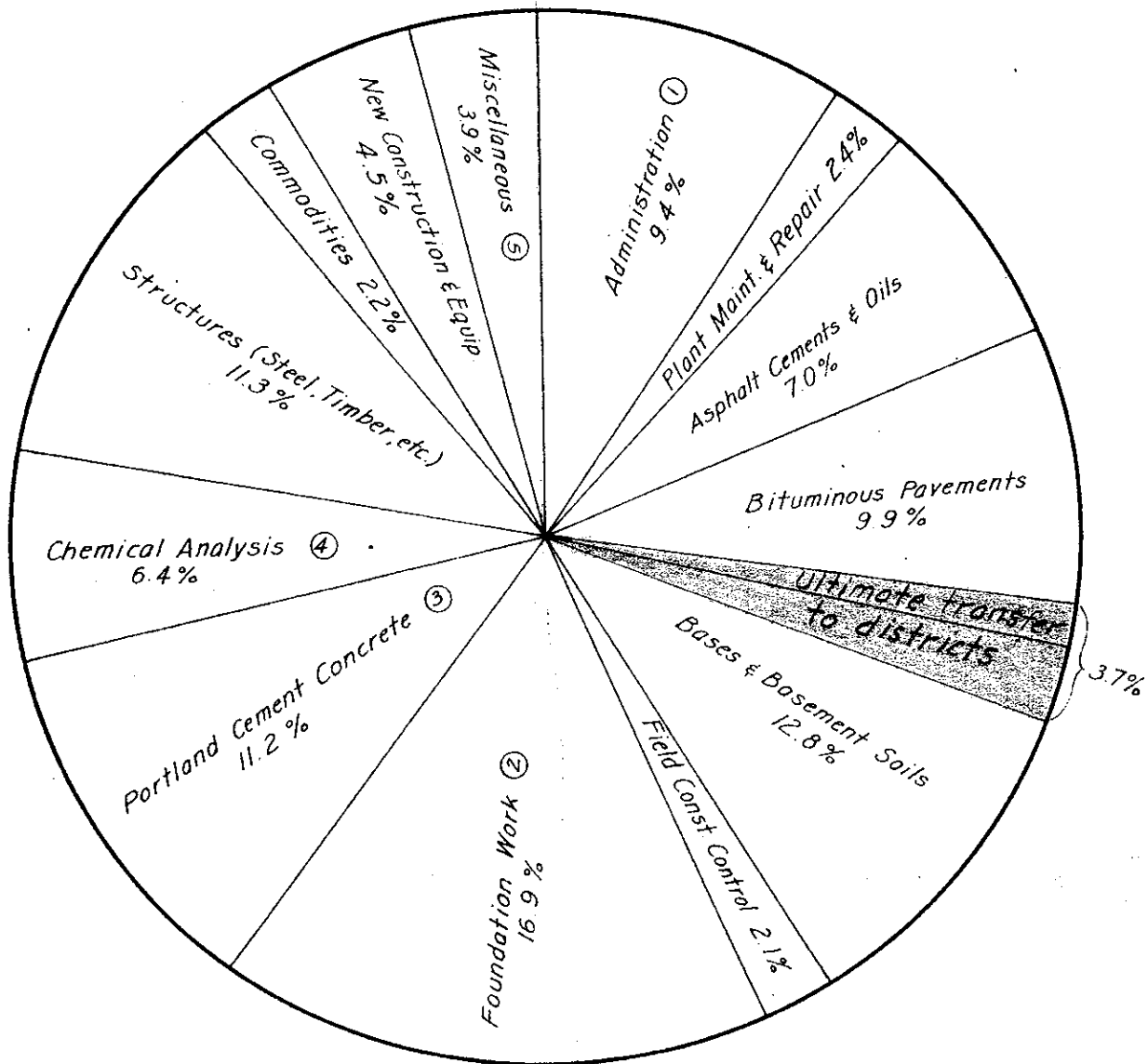


Fig. VI
Typical Laboratory Payroll Distribution
Based on
Activities or Items Tested
(June, 1953 Payroll)



1. Includes Personnel, Accounting, Front Office, etc.
2. Includes Borings, Slope Stability, Slide Analysis & Corrective Treatment
3. Includes Cement Testing & Concrete for Structures & Pavements
4. Includes Testing of Protective Coatings and Traffic Paint Devices
5. Includes Contact and Cooperation with Technical Organizations; Discussion or Consultation with Vendors; Training of Employees

Fig. VII
Typical Laboratory Payroll Distribution
Based on Duties and Responsibilities
of Individual Employees
(June, 1953 Payroll)

